Sacramento Valley Walnut News

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In This Issue

Submitted by:

Janine Hasey
UCCE Farm Advisor *Emeritus*
Sutter, Yuba and Colusa Counties

Orchard Management Considerations: Budbreak through Early Summer

Katherine Jarvis-Shean, UCCE Orchard Advisor, Sacramento, Solano and Yolo Counties
Luke Milliron, UCCE Orchard Advisor, Butte, Glenn, & Tehama Counites
Janine Hasey, UCCE Farm Advisor Emerita, Sutter, Yuba, Colusa Counties

MARCH-APRIL

✓ Timing of your first **walnut blight** spray should depend on the orchard's disease history and forecast weather. If rain is forecast and the orchard has high blight history, consider spraying as early as bud break or catkin emergence and then following up with a second spray 7-10 days later. If pressure in the block is moderate/low (low disease history or no rain forecasted), consider the timing of 20% prayer stage. Learn more at: sacvalleyorchards.com/walnuts/diseases/walnut-blight-management

✓ Limbs that have been killed by **Bot canker** are easy to identify between budbreak and full leaf expansion but wait to prune dead wood until rain is no longer in the forecast.

✓ **Hang codling moth** traps by mid-March to establish the first flight biofix (typically between mid-March and mid- April), begin tracking degree days, and evaluate pest pressure. For details on monitoring and managing codling moth, visit: ipm.ucanr.edu/agriculture/walnut/Codling-Moth.

Did you miss the UCCE Virtual Walnut Series? Recordings are up!

Day 1: youtube.com/watch?v=G1TI68kINmQ&t=3s

- Early Season Water Management
- Overview of UC Walnut Varieties and the Walnut Improvement Program
- California Walnuts Industry Update
- Walnut Training Update
- The Four R's of Nitrogen Management
- Walnut Whole Orchard Recycling: Early Results

Day 2: youtube.com/watch?v=Irxdb9fuLMU&t=2s

- Managing Rodent Pests in Walnuts – What's New?
- Walnut Rootstocks and Diseases
- Blight Update
- Navel Orange Worm, Codling Moth and Pacific Flathead Borer Updates

The UCCE Virtual Walnut Series and these recordings were made possible by the generous support of the California Walnut Board.

- ✓ Consider putting out **navel orangeworm (NOW)** pheromone traps for adult males and traps baited with ground pistachio meal for adult females.
- ✓ Monitor for **scale crawlers** by putting out double-sided sticky tape by early- to mid-April if scale has been a problem and you didn't treat for scale during the dormant season.
- ✓ For varieties susceptible to **pistillate flower abscission (PFA)** (especially Tulare or Serr), apply first ReTain® spray at 30 to 40% pistillate (female) flower bloom. The percent PFA and rate of bloom determines if a second spray is needed. ReTain® cannot be applied within 2 days of a copper application. PFA often occurs in years when trees have a heavy catkin load and pollen shedding overlaps with pistillate bloom.
- ✓ Apply **foliar zinc** if needed, based on leaf sample analysis or symptoms. Apply when shoots are 6 to 10 inches long, when zinc can be easily absorbed through the leaf surface. If the deficiency is severe, additional sprays can be applied two more times, every 2 to 3 weeks.
- ✓ Perform **irrigation system maintenance** now, before irrigation is necessary and system problems could cause tree stress. Check for broken or clogged filters and emitters. More information available at: sacvalleyorchards.com/almonds/irrigation/irrigation-system-maintenance.
    - o If you farm in Tehama, Butte, Colusa, Glenn, Shasta or Yolo counties, you can apply for a free system evaluation from the Tehama Resource Conservation District Mobile Irrigation Lab by contacting Kevin Greer (530) 727 – 1297, kevin@tehamacountyrcd.org.

MAY

- ✓ **Before you start irrigating,** consider plant water stress (pressure chamber) measurements and soil moisture sensor readings. Ongoing research in the Sacramento Valley has found irrigation can be delayed until June in some years, saving water and pumping costs without negative impacts to yield, size or quality. See the article in this newsletter for more information.
- ✓ As we go into another lean price year, consider your IPM program through the lens of an **IPM economic treatment threshold**. With the value of the crop down, this may change the population level at which it makes economic sense to treat. See more at sacvalleyorchards.com/walnuts/cost-and-expense-considerations/cost-saving-strategies-for-insect-mite-management.
- ✓ Continue monitoring **codling moth** traps to confirm flight activity and determine treatment thresholds and timings.
- ✓ **Aphid** sampling should begin this month and continue throughout spring and summer. Collect 5 first sub-terminal leaflets (one back from the last leaflet) from 10 trees, checking the top surface for dusky-veined aphids and the underside for walnut aphids. Make treatment decisions following guidelines at: ipm.ucanr.edu/PMG/r881300511.html.
- ✓ **Walnut blight** infections remain a concern through May. Amidst lean prices, if you are trying to save a spray, consider trying the Xanthocast model, which uses leaf wetness and temperature for forecasting disease risk and timing re-treatment intervals. Model at: agtelemetry.com/Walnut-Blight-Calculator.php
- ✓ Apply the first round of **nitrogen fertilizer** in May, not before. Walnut trees only use stored nitrogen the first month after leaf-out, meaning N applied before May will likely be leached by rain and/or irrigation. Walnut tree nitrogen use is fairly steady over the growing season. Evenly dividing nitrogen applications in 3 to 4 doses between May and mid-August will improve N uptake compared to 1 to 2 applications.

- ✓ Survey **weeds** to see which weeds were not controlled by fall or winter treatment. The UC Weed ID Tool at weedid.wisc.edu/ca/weedid.php can help with identification. Also see Herbicide Chart in this newsletter.
- ✓ If our relatively dry past winter means you may be relying on groundwater more than usual this year, or you think your water quality may have changed, take a **water sample** to evaluate for specific elements like B, Cl, and Na, if they can be a problem in your area. Water quality thresholds at: sacvalleyorchards.com/walnuts/irrigation-walnuts/evaluating-water-supply-for-irrigating-nut-crops

JUNE

- ✓ Keep an eye on soil moisture and/or stem water potential to **avoid overwatering**, and potential subsequent harm to root and overall tree health. If using the pressure chamber, waiting to irrigate until trees are 2 to 3 bars drier than the fully watered baseline is a prudent approach. Learn more at sacvalleyorchards.com/manuals/stem-water-potential/pressure-chamber-advanced-interpretation-in-walnut.
- ✓ Hang **walnut husk fly** traps by June 1. Yellow sticky traps charged with an ammonium carbonate lure work best. Check traps 2 to 3 times per week and treat based on detection of eggs in trapped females, overall trap catch numbers, or the first flies caught depending on spray material used, husk fly population, and previous damage. For more details on treatment decision-making, see: sacvalleyorchards.com/walnuts/insects-mites-walnuts/walnut-husk-fly-biology-monitoring-and-spray-timing.
- ✓ Keep monitoring **codling moth** traps, to determine subsequent biofixes. Use trap catches, dropped nut evaluation, canopy counts, and orchard history to determine need to treat second flight (see UC IPM link above).
- ✓ Look for **spider mites** and their predators on the leaflets already being examined for aphids. Examine an additional 5 leaflets from higher branches for a total of 10 leaflets from 10 trees. Yellows sticky cards for sixspotted thrips will also inform presence and activity of this spider mite predator. Monitor weekly through August. Treatment guidelines based on spider mite and predator presence, as well as organophosphate or pyrethroid use can be found at ipm.ucanr.edu/PMG/r881400111.html.
- ✓ If applying only one fungicide spray for **Bot canker**, a mid-June to mid-July spray timing significantly reduced blighted shoots compared with a no spray treatment. Prune out dead branches to reduce inoculum now that threat of rain has passed.

New walnut variety 'UC Wolfskill' released

Chuck Leslie and Pat J. Brown, UC Davis Walnut Improvement Program,
UC Davis Dept. of Plant Sciences

The UC Davis Walnut Breeding Program has recently released a new walnut variety, 'UC Wolfskill'.

'UC Wolfskill' harvests earlier than 'Chandler', 'Howard', or 'Tulare'. Harvest timing is similar to 'Solano' with better kernel color, and a thinner shell. Trees yield abundantly at maturity. The smooth-shelled nuts are similar to 'Chandler', with an attractive appearance and solid seals.

Data from more than a decade of evaluation across seven locations show that 'UC Wolfskill' kernels are slightly larger, and nuts are consistently better-filled than Chandler trees of the same age, with excellent, Chandler-like color. In multiple years of blind kernel evaluations provided by a major commercial walnut processor, 'UC Wolfskill' nuts have consistently been misidentified as 'Chandler', suggesting that their commercial value will be comparable.

'UC Wolfskill' is the result from a 2003 cross between 'Chandler' and 'Solano'. Leafing, flowering, and harvest dates are similar to 'Solano', and kernel quality and color are similar to 'Chandler'. Given the earlier leaf-out, blight management similar to other early varieties may be necessary depending on local weather conditions. 'Chandler', 'Howard', or 'Tulare' are all suitable pollenizers for 'UC Wolfskill', which offers growers an early harvest option with 'Chandler' nut quality attributes.

'UC Wolfskill' is now commercially available to California growers and can be ordered from any licensed nursery. You can learn more about the attributes of other recent releases and industry standards at: sacvalleyorchards.com/walnuts/orchard-development/cultivars.

Figure 1. Unpruned, unheaded, 5th-leaf 'UC Wolfskill' tree (photo by J. Hasey).

Figure 2. 'UC Wolfskill' nuts at hullsplit (photo by J. Hasey).

Figure 3. Nuts and kernels of 'UC Wolfskill'.

Pulling the trigger for the start of irrigation in the spring: Too much too soon for walnuts?

Ken Shackel, Plant Sciences Department, UC Davis
Allan Fulton, UCCE Soil and Water Advisor, Emeritus
Kari Arnold, UCCE Orchard & Vineyard Advisor, Stanislaus County
Bruce Lampinen, UCCE Specialist, UC Davis
Luke Milliron, UCCE Orchard Advisor, Butte, Glenn, & Tehama Counties

Walnuts are generally regarded as very sensitive to water stress. Severe stress and defoliation can occur when irrigation is reduced in the summer or discontinued entirely for harvest. Since walnuts depend on stored soil moisture during this time, growers were historically advised to start irrigation early in the spring to save deep soil moisture 'in the bank' for use later in the season. However, research findings in a Red Bluff, CA walnut orchard have seriously challenged this conventional wisdom. In fact, trees that were given an early start of irrigation (late April), showed more water stress at harvest than trees that were given a delayed start of irrigation (late May/early June). Surprisingly, this occurred despite the fact that the delayed start trees received substantially less water (about 28 inches over the course of the growing season) than the early start trees (about 38 inches). The Red Bluff orchard is on a deep silt-loam/fine sandy-loam soil, but similar results are being found in one Stanislaus County orchard on a heavier clay soil and one orchard in western Tehama County on stratified soils, with gravelly subsoils and much lower water holding capacity.

Using the right tool:
In many commercial orchards, in-season tree water stress is monitored by measuring midday stem water potential (SWP) using a pressure chamber, (a.k.a. "pressure bomb," see sacvalleyorchards.com/manuals). This same tool could be used specifically to decide when to start irrigation in the spring, with the appropriate information on this subject. As a starting point, there is a reference level of SWP that is expected for a fully irrigated (non-stressed) walnut tree, which is called the "Baseline" SWP. For more information about baseline SWP and how to obtain this value for a particular location, day, and time, we suggest the following websites:

Baseline and advanced interpretation explained: sacvalleyorchards.com/manuals/stem-water-potential/using-baseline-swp-for-precise-interpretation/

Baseline values calculated for you at: informatics.plantsciences.ucdavis.edu/Brooke_Jacobs/index.php

Using the tool to trigger the start of irrigation:
We began testing in 2014 in a 9-year old commercial Chandler/Paradox orchard planted at 18 x 28 ft (86 trees per acre) on a deep, well-drained silt-loam/fine sandy-loam soil near Red Bluff, CA. The test continued through 2019. The design of the experiment was simple: we compared control trees given 100% irrigation (see below) starting about 30 days after leafout, to trees which were not irrigated until a trigger level of SWP was reached. We tested five trigger levels for the start of irrigation: a grower control (typically starting irrigation while the trees were still near baseline SWP), or 1, 2, 3, or 4 bars drier than baseline SWP.

We divided the field into 4 row X 11 tree plots and had 5 individual plots for each trigger level. All total, the test consisted of 12.5 acres. Starting after leafout (about the third week of April), we measured the SWP of 2 middle trees in each plot every three or four days, and when the average of those trees reached the trigger on 2 consecutive dates, we opened the sprinkler control valves to the tree rows in that plot. From then on, the plot was irrigated whenever the control plots and the rest of the orchard was irrigated.

Initial results in 2014:

We expected that a 1 or 2 bar trigger might cause mild water stress with minimal effect on the trees, but that the 3 or 4 bar triggers would show some detrimental effects. However, we were not sure how long of a delay would result by waiting to start irrigation using any of these trigger levels. We were also not sure if trees with late triggers would always be 'behind' in their water needs, and would experience severe water stress at harvest, because we couldn't apply a 'catch up' irrigation to any of the trees that were delayed. In 2014, the 1 bar trigger occurred about the same time as the grower control, but much to our surprise, waiting for the 2 bar trigger gave 1 - 2 months of delay (depending on the plot), with the 3 and 4 bar triggers giving slightly longer delays (Table 1).

Longer delays also resulted in less irrigation. In 2014, the control trees received 100% of calculated evapotranspiration (ET, see anrcatalog.ucanr.edu/pdf/8533.pdf), whereas the 1 through 4 bar trees ranged from 89% to 66% of this value, respectively (Table 1). There were some negative effects on crop yield, with the 4 bar trigger reducing yield by about 10% (Table 1), but there were also some positive signs. For instance, at harvest in October, the 2, 3, and 4 bar triggers had a healthier canopy appearance than the controls. This matched our SWP measurements, which indicated that the delayed trees were actually less stressed than the controls (Table 2). This was the most surprising result from the first year of the study: during the delay period (May, June) the longer delays were associated with more stressed (more negative) SWP values, as expected, with the controls being closest to the baseline. However, by harvest, the opposite was the case, with the controls being furthest from the baseline (Table 2).

Table 1. Irrigation start dates, seasonal irrigation applied (in inches and as the equivalent percent of irrigation requirement, calculated from ET minus in-season rainfall), and crop yield, for each of the irrigation treatments imposed in the first year of the study (2014).

SWP trigger for the first irrigation	2014 (ET-in season rain = 38")			
	Irrigation start date	Irrigation applied	% of ET-rain	Yield (pounds/acre dry inshell)
At or near baseline (control)	April 26	38"	100%	3690
1 bar below baseline	April 26	34"	89%	3700
2 bars below baseline	May 28-June 18	30"	79%	3440
3 bars below baseline	June 2 - June 13	25"	66%	3420
4 bars below baseline	June 2 - June 13	25"	66%	3360

Table 2. Average SWP measured in May and June 2014, when irrigation was being delayed in most of the treatments, and average SWP in October around harvest (October 17, 2014). Also shown are the baseline SWP values for the same time periods.

SWP Trigger for the first irrigation	Measured SWP in	
	May-June (Baseline = -4.4)	October (Baseline = -4.3)
At or near baseline (control)	-5.2	-5.8
1 bar below baseline	-5.2	-4.9
2 bars below baseline	-5.9	-4.6
3 bars below baseline	-6.7	-4.2
4 bars below baseline	-7	-5.7

Trial results for 2015-2018:

Due to the overall improved appearance of trees in the delayed plots at harvest compared to the controls, the grower's standard (control) irrigation start time in the entire orchard, including our control plots, was gradually delayed each year after 2014. Water applications in the orchard and the control plots became substantially less than 100% of the seasonal irrigation need (Table 3). Yields also generally improved across treatments compared to 2014, even though canopy size, as measured by midsummer ground shaded area, has remained stable at 86%. Even with the changes over time that occurred in the control trees, delays associated with a 1 to 4 bar trigger showed small but consistent improvements in percent edible yield and relative value, and a substantial savings in water (Table 3). There were also indications of small but consistent increases in nut load, but since nut load is determined by many factors, ongoing research in additional orchards is being conducted to determine if this effect is consistent.

Table 3. Average irrigation start date (and equivalent days after leafout), seasonal irrigation applied in inches (and equivalent percent of the seasonal irrigation requirement, as in Table 1), yield, percent edible yield, relative value, and crop relative value (and equivalent percent of the control treatment). Relative value is an index combining the two main economic drivers of walnut value (percent edible yield and kernel color), and crop relative value is Yield x Relative value.

SWP Trigger for the first irrigation	Average 2015-2018 (ET-rain: 38.6")					
	Irrigation start date (days after leafout)	inches irrigation (% ET-R)	yield (pounds/acre dry inshell)	% edible yield	Relative Value	Relative crop value (% of control)
At or near baseline (control)	Late April/Early May (25-35)	24.4 (63%)	5360	45.1	89.6	4840 (100%)
1 bar below baseline	Mid to late May (45-60)	22.5 (58%)	5230	45.5	90.9	4760 (98%)
2 bars below baseline	Early to mid June (60-75)	20.7 (54%)	5000	45.1	90.2	4540 (94%)
3 bars below baseline	Mid to late June (75-85)	16.9 (44%)	5080	45.9	91.3	4660 (96%)
4 bars below baseline	Late June to early July (85-95)	18.3 (47%)	4940	45.9	91.3	4530 (94%)

Soil moisture storage & possible implication for root health:

The soil in this location is a deep, well-drained silt-loam/fine sandy-loam, and soil moisture measurements have indicated that the trees in this orchard have access to at least 10 feet of stored soil moisture. In most years, rainfall is also sufficient to refill this soil profile. Hence, using the pressure chamber to determine when to start irrigating has enabled the grower to take maximum advantage of this soil moisture resource. At the same time, allowing the trees to use stored soil moisture in the spring may improve soil aeration and overall root health. This may be one of the reasons why the delayed trees appeared healthier and were less stressed around harvest compared to the controls. Answering this question with greater confidence will require more research focused on the root system.

Taking the delay of irrigation with SWP practice beyond Red Bluff:
It is also important to test the delayed irrigation approach on different soil types. Because this project was conducted in a relatively high rainfall area in the Sacramento Valley, extending these dramatic results to other areas in the state with differing rainfall and soils should be done with caution. We currently have two different trials underway to further test the merits of delaying the start of irrigation in walnut. A second site in Stanislaus County on a heavier clay soil and a third trial in western Tehama County on stratified soils, with gravelly subsoils and much lower water holding capacity. Both trials are a smaller scale version of the Red Bluff trial.

In a Stanislaus orchard consisting of Chandler on Vlach, results after three years suggest that similar benefits of delaying the first irrigation may be possible in this higher clay content soil site. Some ailing trees have shown partial recovery in the delay treatment, indicating the possibility of too much water being applied too early (figure 1). Yield at the Stanislaus site was not affected when irrigation was withheld until readings of 2 bars drier than baseline.

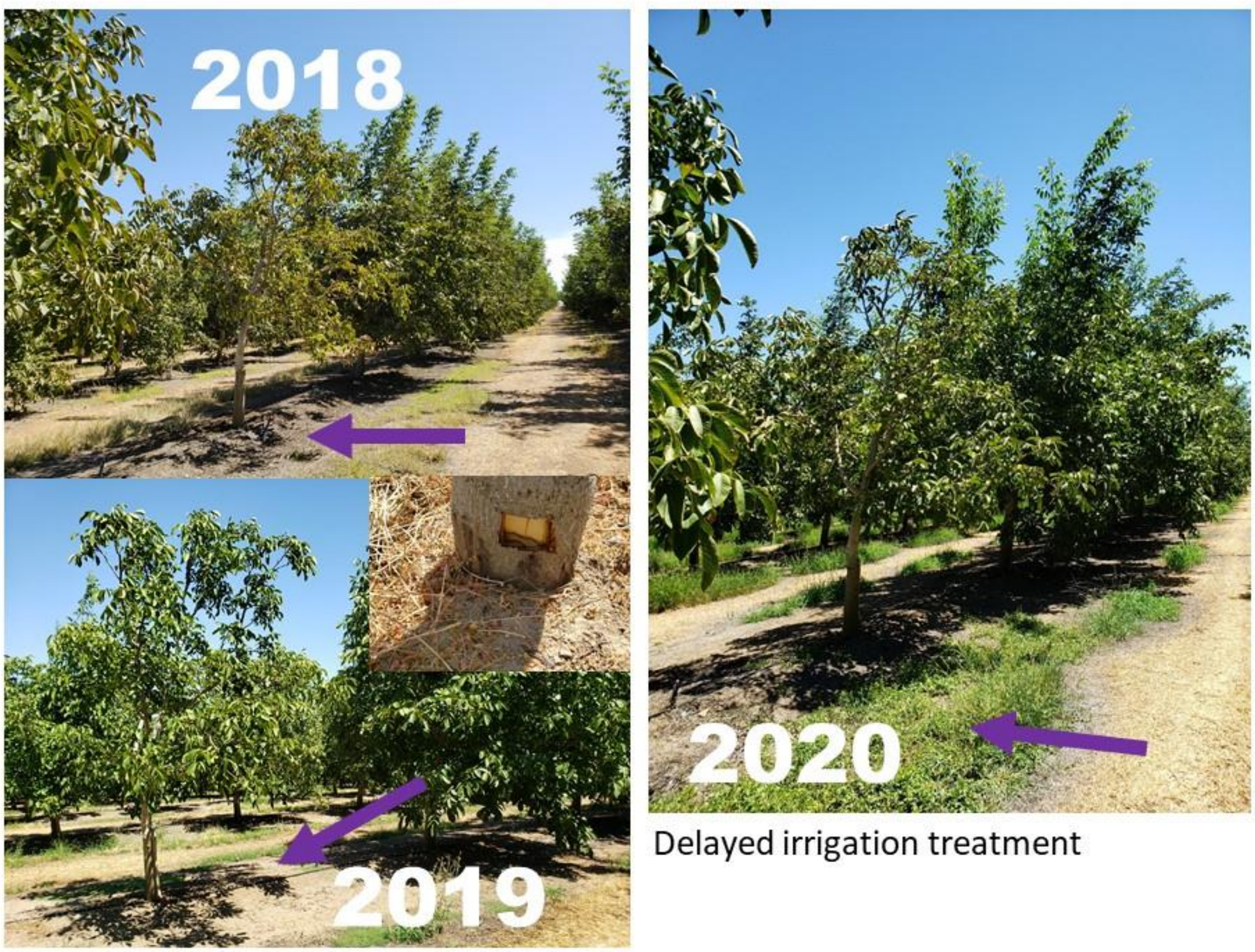

Figure 1. An ailing tree at the Stanislaus site in 2018 showed signs of deterioration. Although the trunk was somewhat sunken at the soil line and necrosis was forming under the bark (center photo), samples were collected multiple times but no *Phytophthora spp.* were isolated/found. This tree happened to be included in the delay irrigation treatment and during the passing of three years appears to be recovering, specifically showing greater shade under the tree canopy at midday since the beginning of the trial in 2018 (photos by K. Arnold).

After two years, results from the western Tehama County test on soils with lower water holding capacity and soil layers that may restrict root depth, suggest there may still be some benefit of delaying irrigation in terms of less tree stress at harvest, reduced water costs, and improved edible kernel. However, as might be expected because of the lower water holding capacity of the soils, the delay may only be about one to two weeks with water savings of about four inches.

A key feature of using SWP to manage irrigation is that it provides growers with an orchard-specific measure of tree water stress, and hence allows them to safely take advantage of the existing soil moisture resource, regardless of soil depth, type, and the quantity of stored soil moisture. Using SWP to delay the start of irrigation resulted in healthier looking, less water stressed trees at harvest, challenging the conventional wisdom that an early start to irrigation is beneficial because it allows the saving of deep soil moisture 'in the bank' for use later in the season. Quite possibly, keeping this savings account too full in the spring may cause more problems than it solves.

The benefits of waiting to irrigate in spring until trees read 2 to 3 bars drier than the baseline despite the stark differences between these three sites, is a powerful testament to the value of using the pressure chamber. Once growers use the pressure chamber to trigger the start of irrigation, they can continue to trigger irrigations throughout the season by waiting for SWP readings of 2 to 3 bars drier than the fully watered baseline.

Baseline and other information for interpreting SWP readings at: sacvalleyorchards.com/manuals/stem-water-potential/pressure-chamber-advanced-interpretation-in-walnut/

These trials are also challenging the conventional wisdom that we must irrigate to keep up with ET to have healthy and high-yielding walnut orchards (figure 2). Stay tuned as these two new trials continue to add to our collection of experiences.

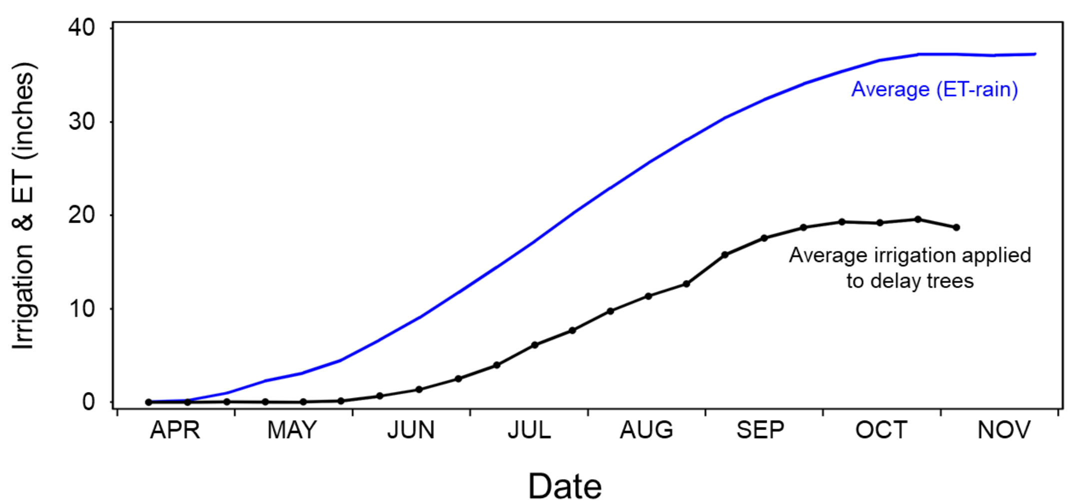

Figure 2. Summary of average orchard water requirement (ET-rain) and applied irrigation for all delayed irrigation tests to date (2014 – 2020). Daily CIMIS values for orchard water requirements were calculated beginning on April 1, based on current walnut crop coefficients, for each site and year, and averaged. Irrigation applied to all delayed treatments for each site and year were averaged for 10 day periods over the same seasons.

New Staff Research Associate Introduction

Evie Smith, UCCE Staff Research Associate, Southern Sacramento Valley

I am excited to be starting my position as a Staff Research Associate working under Dr. Katherine Jarvis-Shean and Dr. Franz Niederholzer in orchard crops in the Southern Sacramento Valley. I was born and raised in Georgia, and attended Auburn University in Alabama for my undergraduate studies in Horticulture and Agronomy. I moved to California in 2017 to do a master's program in International Agricultural Development and subsequently a master's program in Horticulture and Agronomy at UC Davis. My research experience and interests focus on connecting farmers with science-based strategies for climate change adaptation, water management, pest management, and confronting other agricultural challenges through applied research and strategic communication. In my free time, I enjoy gardening, cooking, hiking, camping, and drinking good coffee. I am grateful to the Almond Board of California, California Pistachio Research Board, and the California Walnut Board for funding my position with UC Cooperative Extension.

Tree and Vine Crop Herbicide Chart – Updated (2021)

Please also find attached the updated tree and vine crop herbicide chart organized by Brad Hanson, UCCE Weed Science Specialist. Remember that rotating and/or mixing herbicides with different modes of action (MOAs) is critical to good weed management, particularly with herbicide-resistant populations. Notes: R = registered, N = Not registered, NB = registered only for Non-Bearing. Always check the current specific herbicide label before use because labels change and there are occasionally differences among products with the same active ingredient.

Herbicide Registration on California Tree and Vine Crops - *(reviewed March 2021 - UC Weed Science)*

	Herbicide-Common Name *(example trade name)*	Site of Action Group[1]	Almond	Pecan	Pistachio	Walnut	Apple	Pear	Apricot	Cherry	Nectarine	Peach	Plum / Prune	Avocado	Citrus	Date	Fig	Grape	Kiwi	Olive	Pomegranate
			----- tree nut -------				- pome -		---------stone fruit ---------												
Preemergence	**dichlobenil** *(Casoron)*	L / 20	N	N	N	N	**R**	**R**	N	**R**	N	N	N	N	N	N	N	**R**	N	N	N
	diuron *(Karmex,Diurex)*	C2 / 7	N	**R**	N	**R**	**R**	**R**	N	N	N	**R**	N	N	**R**	N	N	**R**	N	**R**	N
	EPTC *(Eptam)*	N / 8	**R**	N	N	**R**	N	N	N	N	N	N	N	N	**R**	N	N	N	N	N	N
	flazasulfuron *(Mission)*	B / 2	**R**	N	**R**	**R**	N	N	N	N	N	N	N	N	**R**	N	N	**R**	N	N	N
	flumioxazin *(Chateau)*	E / 14	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	NB	NB	N	NB	**R**	N	**R**	**R**
	indaziflam *(Alion)*	L / 29	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	N	**R**	N	N	**R**	N	**R**	N
	isoxaben *(Trellis)*	L / 21	**R**	**R**	**R**	**R**	NB	NB	NB	NB	NB	NB	NB	NB	NB	N	NB	**R**	NB	NB	NB
	mesotrione *(Broadworks)*	F2/27	**R**	**R**	**R**	**R**	N	N	N	N	**R**	N	**R**	N	**R**	N	N	N	N	N	N
	napropamide *(Devrinol)*	K3 / 15	**R**	N	N	N	N	N	N	N	N	N	N	N	N	N	N	**R**	**R**	N	N
	norflurazon *(Solicam)*	F1 / 12	**R**	**R**	N	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	N	N	**R**	N	N	N
	oryzalin *(Surflan)*	K1 / 3	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	N	**R**	**R**	**R**	**R**	**R**
	oxyfluorfen *(Goal, GoalTender)*	E / 14	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	NB	**R**	**R**	**R**	**R**	**R**	**R**
	pendimethalin *(Prowl H2O)*	K1 / 3	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	N	**R**	N	N	**R**	**R**	**R**	**R**
	penoxsulam *(Pindar GT)*	B / 2	**R**	**R**	**R**	**R**	N	N	N	**R**	**R**	**R**	**R**	N	N	N	N	N	N	**R**	**R**
	pronamide *(Kerb)*	K1 / 3	N	N	N	N	**R**	**R**	**R**	**R**	**R**	**R**	**R**	N	N	N	N	**R**	N	N	N
	rimsulfuron *(Matrix)*	B / 2	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	N	**R**	N	N	**R**	N	N	N
	sulfentrazone *(Zeus)*	E / 14	N	N	**R**	**R**	N	N	N	N	N	N	N	N	**R**	N	N	**R**	N	N	N
	simazine *(Princep,Caliber 90)*	C1 / 5	**R**	**R**	N	**R**	**R**	**R**	N	**R**[2]	**R**	**R**	N	**R**	**R**	N	N	**R**	N	**R**	N
	trifluralin *(Treflan)*	K1 / 3	**R**	**R**	N	**R**	N	N	**R**	N	**R**	**R**	**R**	N	**R**	N	N	**R**	N	N	N
Postemergence	**carfentrazone** *(Shark EW)*	E / 14	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**
	clethodim *(SelectMax)*	A / 1	**R**	**R**	**R**	**R**	NB	NB	NB	NB	NB	NB	NB	N	**R**	N	N	NB	N	NB	N
	2,4-D *(Clean-crop, Orchard Master)*	O / 4	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	N	N	N	N	**R**	N	N	N
	diquat *(Diquat)*	D / 22	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB
	fluazifop-p-butyl *(Fusilade)*	A / 1	NB	**R**	NB	NB	NB	NB	**R**	**R**	**R**	**R**	**R**	NB	**R**	NB	NB	**R**	N	NB	NB
	glyphosate *(Roundup)*	G / 9	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**
	glufosinate *(Rely 280)*	H / 10	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	N	**R**	N	N	**R**	N	**R**	N
	halosulfuron *(Sandea)*	B / 2	N	**R**	**R**	**R**	**R**	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	paraquat *(Gramoxone)*	D / 22	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	N	**R**	**R**	**R**	**R**	**R**
	pelargonic acid *(Scythe)*	NC	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	N
	pyraflufen *(Venue)*	E / 14	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	N	N	**R**	**R**	**R**	**R**	**R**	**R**
	saflufenacil *(Treevix)*	E / 14	**R**	N	**R**	**R**	**R**	**R**	N	N	N	N	N	N	**R**	N	N	N	N	**R**	**R**
	sethoxydim *(Poast)*	A / 1	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	NB	NB	**R**	NB	NB	**R**	N	NB	NB
Organic	**ammonium nanoate** *(Axxe)*	NC	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	N
	ammoniated fatty acids *(Final-San-O)*	NC	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**
	caprilic/Capric acid *(Suppress)*	NC	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	N	N	**R**	**R**	N	**R**
	d-limonene *(AvengerAG)*	NC	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	N	**R**	N	N	**R**	N	N	N
	eugenol *(Weed Slayer CA)*	NC	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**

Notes: R = Registered, N = Not registered, NB = nonbearing. This chart is intended as a general guide only. Always consult a current label before using any herbicide as labels change frequently and often contain special restrictions regarding use of a company's product.

[1] Herbicide site of action designations are according to the Herbicide Resistance Action Committee (letters) and the Weed Science Society of America (number) systems. NC = no accepted site of action classification; these contact herbicides are general membrane disruptors. [2]Simazine is registered on only tart cherry in CA. Weed susceptibility information and the most up to date version of this table can be found at the Weed Research and Information Center

WALNUT: BACTERICIDE AND FUNGICIDE EFFICACY – Conventional Chemistries

Tables are currently under review and are expected to be made official in the coming weeks.

Material	Resistance risk (FRAC#)[1]	Walnut blight[2]	Anthrac-nose	Botryo-sphaeria blight***	Kernel mold***
Bactericides					
Copper+mancozeb (Manzate,Dithane)	low (M1+M3)	++++	++++	++(+)	----
Kasumin+copper	low (24+M1)	++++	----	----	----
Kasumin+mancozeb	low (24+M3)	++++	----	----	----
Syllit*+copper	high (U12+M3)	+++	ND	----	----
Bordeaux[2]	low (M1)	+++	----	----	----
Fixed coppers[2,3]	medium (M1)	+++	----	----	----
Zinc sulfate+copper+hydrated lime (Zinc Bordeaux)	low (M1)	+++	----	ND	----
Kasumin	high (24)	+++	----	----	----
Copper+mancozeb+ surfactant[4]	low (M1+M3)	+	ND	ND	----
Fungicides					
Luna Experience	medium (3/7)	----	++++	++++	ND
Luna Experience+Regalia	medium (3/7+ (natural product)	++	++++	++++	ND
Merivon	medium (7/11)	----	++++	++++	++
Pristine	medium (7/11)	----	++++	++++	ND
Quash	high (3)	----	++++	++++	ND
Quilt Xcel,Xiphosin	medium (3/11)	----	++++	++++	ND
Luna Sensation	medium (7/11)	----	++++	++++	ND
Quadris Top	medium (3/11)	----	++++	+++	ND
Ph-D	medium (19)	----	++++	+++	ND
K-Phite[3]	low (P07,33)	+	ND	++++	ND
Fontelis	high (7)	----	ND	+++	ND
Cevya	high (3)	----	ND	+++	ND
Tebucon,Teb,Toledo,Miresa	high (3)	----	ND	+++	++
Miravis Duo	medium (3/7)	-----	ND	+++	ND
Viathon	medium (3/P07, 33)	ND	ND	+++	ND
Rhyme	high (3)	----	++++	ND	++
Abound/Mazolin	high (11)	----	ND	ND	ND
Luna Privilege	high (7)	----	ND	ND	ND

WALNUT: BACTERICIDE EFFICACY – Soft Chemistries (Biologicals and Natural Products)

Organic treatments	Resistance risk (FRAC#)[1]	Walnut blight[2]
Bordeaux[2] (organic with approved copper)	low (M1)	+++
Fixed coppers[2,3] (organic with approved copper)	medium (M1)	+++
Zinc sulfate+copper+hydrated lime (Zinc Bordeaux) (organic with approved copper)	low (M1)	+++
Actinovate	low (biological)	++
Regalia	low (natural product)	++
Regalia+Copper (organic with approved copper)	low (natural product+M1)	++
Blossom Protect	low (biological)	+/++
Serenade (organic)	low (44)	+

Rating: ++++ = excellent and consistent, +++ = good and reliable, ++ = moderate and variable, + = limited and erratic, ---- = ineffective, and ND = no data.

* **Registration pending in California**

**** Not registered, label withdrawn or inactive in California**

***** Research is ongoing to determine the most efficacious materials and the optimum timing of treatments for management of Botryosphaeria blight and kernel mold of walnut. Fungicides rated for kernel mold may have to be mixed (e.g., Merivon -FC 7/11 and Teb-FC 3) and rotated to another fungicide (e.g., Rhyme - FC-3). This mixture rotation is '+++'.**

[1] Code numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://www.frac.info/). Fungicides with a different Code number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action Code numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action Code number; for fungicides with other Code numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action Code number.
[2] Copper resistance occurs within sub-populations of *Xanthomonas arboricola* pv. *juglandis*.
[3] Phytotoxicity may occur. For fixed coppers, injury can be reduced by the addition of lime or agricultural oils to the tank mixture.
[4] A single application with a surfactant is not recommended because of build-up of populations on buds that may increase disease in subsequent years.

WALNUT: TREATMENT TIMING

Note: Timings listed are effective, but not all may be required for disease control. Timings used will depend upon orchard history of disease and weather conditions each year.

Disease	Catkin Emerg-ence	Terminal bud break	7-10 day intervals	Apr.	May	June	July	Aug. (3-wk before hull split)	Sept. (20-30% hull split)	Oct.	Nov. (1st wk)
Anthracnose[1]	----	----	----	++[4]	+++	++	----	----	----	----	----
Botryo-sphaeria blight	----	----	----	+	++	+++	+++	++	----	+	+
Kernel mold[2]	----	----	----	----	----	----	----	++	++	----	----
Walnut blight [3,4,5]	++[5]	+++	+++	+++	++	+	----	----	----	----	----

[1] Make the first application when the size of the expanding leaves is about half of its final size. This first application stage is critical.
[2] Timing for kernel mold is based on a mixture rotation of Merivon (FC 7/11) and Teb (FC 3) followed by Rhyme (FC-3) at the timings indicated. This mixture rotation is '+++' based on the ratings in the efficacy table above.
[3] A temperature-leaf wetness model (e.g., XanthoCast) is available for determining optimum timing of bactericide applications.
[4] Late spring rains are less conducive to disease, provided bloom is not delayed by low chilling.
[5] Male and female flowers are susceptible beginning with their emergence, depending on wetness and temperatures conducive to disease development.